BIODIESEL

On The Road To Fueling The Future

- THE CLEAR CHOICE FOR CLEAN AIR
- RIGOROUS STANDARDS ENSURE BIODIESEL PERFORMANCE
- BIODIESEL IS LUBRICITY
- CASE HISTORIES FROM SELECTED BIODIESEL USERS AROUND THE COUNTRY

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Biodiesel: On The Road To Fueling The Future

by Karl Lang, Hart/IRI Fuels Information Services

If Wall Street's last twelve months have confirmed anything it is that a diversified portfolio is the hallmark of a wise investor. The same could be said about our nation's energy supply. In the words of Energy Secretary Spencer Abraham, the country's new energy strategy should be *"… founded on the understanding that diversity of supply means security of supply, and that a broad mix of supply options … will help protect consumers from price spikes and supply disruptions."* European nations have realized the value of this supply diversity, having relied on biodiesel as a component in their fuel mix for the last 20 years.

Biodiesel is an obvious choice for providing that diversity in our energy mix as well, while simultaneously improving the quality of our air, expanding our domestic economy, and reducing our contribution to global warming. After a decade of testing and demonstration in the U.S., a critical mass of biodiesel users has emerged and the industry is poised for rapid growth.

The facts support this view. Between March 1999 and March 2001 the number of major fleet managers choosing biodiesel increased 20-fold. The number of registered biodiesel suppliers has grown from two to seventeen, with more poised to come online. Since 1997, seven companies have released premium additive packages containing biodiesel. Both Ford and Chrysler have begun biodiesel research initiatives, and the use of B20 in existing diesel engines does not void parts and materials workmanship warranties of any major engine manufacturer. Also, biodiesel is attracting broad support for initiatives to make it a cost-competitive option for achieving state and federal policy goals.

But perhaps the most important boost to biodiesel's market value will come from the pressure to reduce sulfur levels in the nation's diesel fuel supply. As a pure fuel, biodiesel contains no sulfur. As a blendstock, even at levels of only 1 to 2 percent, biodiesel has been shown to restore the lubricity lost by the desulfurization of petroleum diesel. And because biodiesel is completely compatible with conventional petroleum diesel, it can be used to immediately and seamlessly transform a diesel fleet into a cleaner burning, alternatively fueled fleet without added investment.

An increasing number of fuel marketers are supplying diesel with performance enhancements rarely found in conventional diesel fuels, to meet specific regional or seasonal user needs. Companies that currently market these "premium" diesel fuels are distributing products that have measurable benefits and meet their customers broad-based demands. Biodiesel is also being used in key agricultural markets in a low blend system to compliment a major fuel marketers premium diesel fuel program. Expansion is expected with marketers looking to set themselves apart from their competition.

Biodiesel's fuel characteristics exceed those of petroleum diesel in cetane number as well as lubricity. Operationally, biodiesel has a higher flash point making it a more versatile fuel where safety is concerned. Its cleaner emissions and appealing odor are clearly an improvement over standard diesel.

Decades from now, we may all be tanking up with hydrogen for our zero-emission, fuel cell-powered, ultra-high efficiency vehicles. But during the transition to that hydrogen economy, we must use every tool in our energy toolbox to achieve our priorities: increasing our energy security, reducing exhaust emissions, reducing greenhouse gas emissions, and generating jobs from domestic resources. Biodiesel helps us meet every one of these goals. As a neat fuel, as blending stock for petroleum diesel fuel, or as a premium fuel additive, biodiesel delivers time tested benefits.

Perhaps we've come full circle. In 1900, while a young Henry Ford was still three years away from launching the company that would propel the United Sates into the Automobile Age, Dr. Rudolf Diesel was demonstrating his engine in Paris. His fuel of choice: vegetable oil. One hundred years later, it looks like his original idea was a good one! ◆

Biodiesel:
On the Road to Fueling the Future

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The Clear Choice for Clean Air

By Jenna Higgins, Special Correspondent

Let's face it, for all its positive traits, the diesel engine has one problem to overcome: its contribution to air pollution. While diesel trucks and buses account for about 6% of miles driven, the EPA reports that diesel accounts for 20% of particulate pollution. One answer to this problem is biodiesel, the fuel made from soybeans and other vegetable oils or fats.

Petroleum-based diesel exhaust

Consider the following:

- Biodiesel can help cut emissions of carbon dioxide (CO_2), the primary greenhouse gas contributing to global warming. The United States' production and consumption of petroleum fuels for vehicles accounts for more than 7 percent of worldwide CO_2 emissions. Biodiesel reduces lifecycle CO_2 emissions by almost 80% compared to petroleum diesel.

- Biodiesel contains no sulfur, so burning it creates no sulfur dioxide. More than 1.5 million tons of sulfur dioxide are produced in the US each year by the burning of fossil fuels in vehicle engines. Sulfur dioxide is harmful to the eyes, throat, and lungs and can form sulfuric acid, the primary component in acid rain.

- Biodiesel has the best energy balance of any liquid fuel. Some alternative fuels are criticized for using as much energy to make the fuel as the fuel contains. This is not the case with biodiesel. Every unit of energy needed to produce biodiesel results in 3.24 units of fuel energy.

Emissions Reductions
(B100 compared to petroleum diesel)

Emissions Drop With Biodiesel

Independent studies show the use of biodiesel in conventional diesel engines results in a substantial reduction of pollutants compared to petroleum diesel fuel. A 1998 biodiesel lifecycle study sponsored by the U.S. Department of Energy and the U.S. Department of Agriculture concluded that pure biodiesel reduces net CO_2 emissions by 78 percent compared to petroleum diesel. That makes biodiesel the best fuel for global warming mitigation. "Biodiesel also reduces emissions when blended with petroleum diesel," says Ann Hegnauer, program manager in the Department of Energy's Office of Fuels Development. "It's one of the few alternative fuels available that works within our existing diesel technology infrastructure. That's a real benefit because

diesel vehicles can last 25 years or more, so those vehicles are not going to go away anytime soon. Biodiesel is a way to clean up the air and improve our domestic energy security without making drastic changes to the system."

According to independent tests performed at Southwest Research Institute, carbon monoxide emissions from a heavy-duty diesel engine were reduced by 50 percent when running on pure biodiesel fuel as compared to petroleum diesel. The data also indicated that burning pure biodiesel resulted in a substantial reduction in emissions of particulate matter and unburned hydrocarbons (a major contributor to smog). Emissions of toxic PAH and nitro-PAH compounds were reduced dramatically compared to petroleum diesel fuel. When biodiesel was blended with petroleum diesel fuel, similar emission trends were observed, although the changes were smaller than for pure biodiesel.

Dump Trucks Clean Up Act

Lab studies are great, but how does biodiesel work in the real world? Just fine, according to a San Francisco Bay-area recycling company which runs its equipment on pure biodiesel. In the summer of 2000, GreenTeam began using pure biodiesel (B100) in all 94 of its recycling and garbage trucks, making it the first fleet of its size fueled by pure biodiesel. "We take pride in being an environmental leader," says Kerynn Gianotti, GreenTeam public affairs manager. "I think you'll start to see more people using 100 percent biodiesel, in California especially, because of the air quality laws that are coming into effect."

An Arizona concrete company also made the switch to B100 in an effort to stop contributing to the area's smog problem. Rockland Materials operates a fleet of about 100 diesel ready-mix trucks, dump trucks and semi tractor-trailers. "We had to come up with a better way for us to contribute to keeping our air clean," says Grant Goodman, owner of Rockland Materials. "My wife and my son are asthmatics, and anyone who's ever seen the impact asthma has on people would probably do the same thing we've done."

Greening up Parks with Biodiesel

The National Park Service (NPS) routinely monitors the health of the marine environment at Channel Islands National Park, off the coast of Southern California. The Park Service also contributes to the well being of the environment by practicing what it preaches.

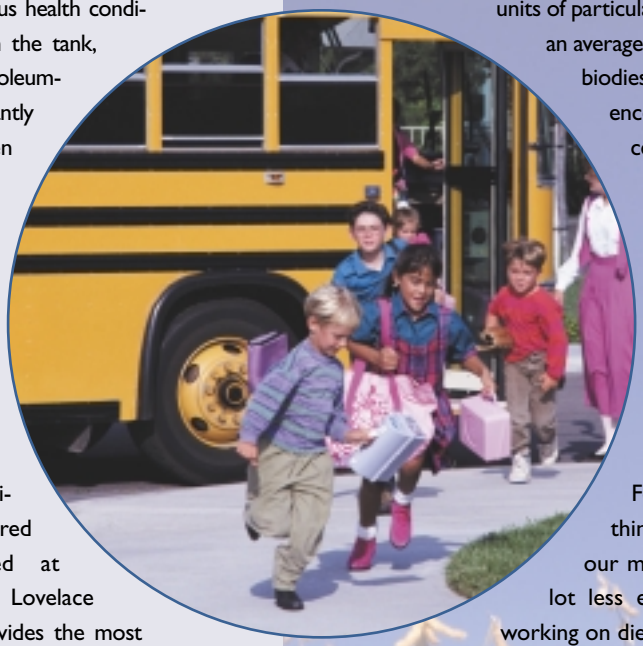
Chris Case, Facility Mgr. For Pictured Rocks National Lakeshore, with truck fueled by biodiesel.

A two-year pilot program now underway at the park has the NPS vessel *Pacific Ranger* running on biodiesel. Unlike petroleum diesel, biodiesel is nontoxic and bio-degradable, which means not only does it burn clean, a spill in the ocean would not have the same consequences as a petroleum diesel spill. "Biodiesel degrades about four times faster than petroleum diesel," says Joe Jobe, executive director of the National Biodiesel Board, the industry's nonprofit trade association. "Within 28 days, pure biodiesel degrades 85 to 88 percent in water. That's about the same rate as Dextrose, a natural sugar used as a control when testing biodegradability." Biodiesel helps improve the biodegradability of petroleum as well. A 20 percent blend of biodiesel improves biodegradability of the blend by 30 percent.

"We're an environmental organization and we should be a leader in demonstrating things that have a positive environmental impact," adds Kent Bullard, maintenance supervisor at Channel Islands National Park. The park is just one of a list of national parks using biodiesel, including Pictured Rocks National Lakeshore in Munising, Michigan, and Yellowstone National Park. "We're stewards charged with protecting a national treasure and we need to keep looking at how we can best do that," concludes Jim Evanoff, Yellowstone National Park management assistant. "Using biodiesel is one of the ways we can protect Yellowstone." ◆

Biodiesel:
So We Can All Breathe Easier

There is no doubt that engine emissions released into the atmosphere are a cause for concern. Engine emissions, particularly from cars and trucks, have been linked with cancer, asthma, and a host of other serious health conditions. Biodegradable and non-toxic in the tank, when burned as an alternative to petroleum-based fuel, biodiesel can also significantly reduce the emissions that threaten human health.



Biodiesel is the first and only alternative fuel to have a complete evaluation of potential emissions-related health effects. Submitted to the U.S. EPA under the Clean Air Act Section 211(b), this evaluation includes the most stringent emissions testing protocols ever required for certification of fuels or fuel additives in the U.S. The data gathered through these tests (performed at Southwest Research Institute and Lovelace Respiratory Research Institute) provides the most thorough inventory of environmental and human health effects technology allows.

The results show that biodiesel significantly reduces the threat to human health compared to petroleum diesel. In fact, its use results in a 90 percent reduction in EPA-targeted air toxics. According to the Department of Energy (DOE), the cancer risk associated with biodiesel particulates is at least 80 percent lower than that associated with exposure to petroleum diesel particulates. Biodiesel emissions have decreased levels of poly-aromatic hydrocarbons (PAH) and nitrated PAH (compounds identified as potential cancer-causing agents). Emissions of most PAH compounds were reduced by 75 to 85 percent when biodiesel was compared to petroleum diesel. The emission of targeted nPAH compounds was also reduced dramatically, with 2-nitrofluorene and 1-nitropyrene volumes reduced by 90 percent and the rest of the nPAH compounds reduced to only trace levels.

Particulate emissions are a "particular" issue with conventional diesel fuel. According to a survey by the Health Effects Institute across 90 cities, for every increase of 10 units of particulates the risk of death rose by an average of 0.4 percent nationally. But biodiesel makes a significant difference, producing up to 50 percent less dangerous particulate emissions than petroleum diesel.

In addition to quantitative independent testing results, scores of biodiesel users have their own anecdotal evidence to attest to the health benefits of biodiesel. For example: "One of the things we discovered is that our mechanics found they have a lot less eye irritation when they're working on diesel vehicles, because there's not that diesel smell and eye irritant," relates John Van de Vaarst, a fleet manager for the Agricultural Research Service within the U.S. Department of Agriculture. "That's been a real positive side benefit that we never expected." ◆

USDA chemist Sevim Erhan compares clear soy-based product with petroleum-based product. (Courtesy of USDA - ARS)

Rigorous Standards Ensure Biodiesel Performance

By Steve Howell, Chemical Engineer, MARC IV and Chairman, Biodiesel Standards Task Force, American Society of Testing and Materials

Since the early 1990s, the biodiesel industry has taken great care to make certain that questions about biodiesel's ability to perform as a high quality fuel were answered well before the product hit the market. As a result, biodiesel is one of the most thoroughly tested alternative fuels in the marketplace. More than $30 million of research sponsored by the National Biodiesel Board, through farmer checkoff investments. Studies performed by the U.S. Department of Energy (DOE), and the U.S. Department of Agriculture (USDA), at world renowned laboratories such as Southwest Research Institute, the Lovelace Respiratory Research Institute, and the University of California – Davis, have measured the properties of biodiesel for everything from energy content to cold flow characteristics.

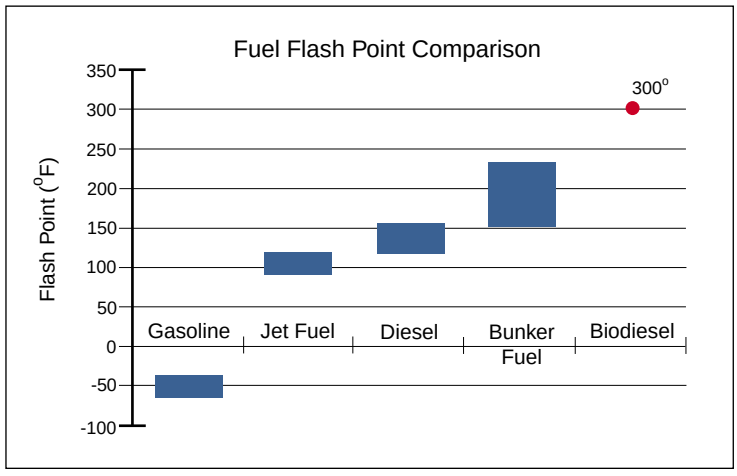
Biodiesel has even passed the "bear" test. A number of years ago, when Yellowstone National Park wanted to begin using biodiesel in its diesel vehicles and generators to reduce offensive emissions, park officials were concerned that bears might be attracted to the appealing "french fry" odor of biodiesel exhaust. "Park managers didn't want grizzly bears coming out of the woods and trailing tourist buses because of the fuel's odor," says Howard Haines, Bioenergy Engineering Specialist for the Montana Department of Environmental Quality. Lacking any data on this aspect of bear behavior, the DEQ carried out a series of tests (including the Bear Attractant and Toxicity Test or BATT). The results showed that unlike picnic baskets, bears were not attracted to biodiesel. Although the BATT is not one of the more widely cited studies, the fact that it was performed illustrates the degree to which biodiesel has been tested.

Biodiesel Meets Performance Objectives

Successful alternative fuels meet environmental and energy security priorities while providing the operating performance demanded by their users. One of the major advantages of biodiesel is that it can be used in existing engines and fuel injection equipment with little impact to operating performance key to diesel users – power, torque and fuel economy. Laboratory research, more than 40 million successful road miles and countless off-road and marine miles have proven that biodiesel performs very similar to petroleum diesel fuel. Biodiesel has a higher cetane number than most U.S. diesel and also has the highest Btu content of any alternative fuel; a Btu content that is comparable, but slightly less than most diesel fuel. Tests indicate there is a marked improvement in lubricity when even low levels of biodiesel are added to diesel.

Safety and Stability A High Priority

Biodiesel is also the safest of all fuels to use, handle and store. It has a flash point (the temperature at which a fuel will ignite when exposed to a spark) much higher than that of petroleum diesel (see chart). "If you throw a match in a bucket of biodiesel, the match will go out," says Leon Schumacher, Associate Professor of Agricultural Systems Management at the University of Missouri. "I've even pointed a propane torch directly at biodiesel. You wouldn't want to try that with petroleum diesel."



In today's "just-in-time" business environment, most fuels are used soon after they are purchased. Many diesel fuel suppliers recommend storing petroleum diesel for no more than three to six months unless using a stabilizing additive. The current industry recommendation is that biodiesel or biodiesel blends also be used within six months. A longer shelf life is possible, (a recent study by the US Navy showed that a 20% addition of a soybean oil-based biodiesel made an unstable diesel fuel become stable) and storage enhancing additives can provide additional benefits. Although storage life has not been a major issue in the field, the industry has a large program underway to develop quicker and more reliable bench tests for measuring the long-term storage stability of biodiesel and the impact of storage enhancing additives.

Biodiesel Meets Cold Weather Challenges

As with conventional No. 2 diesel, proper precautions should be taken with biodiesel and biodiesel blends during cold weather. The gelling of any diesel fuel in cold climates

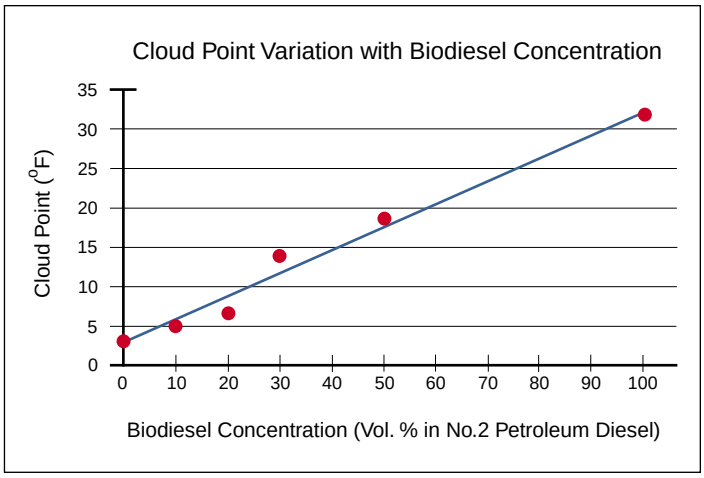
is a commonly known phenomenon and diesel fuel suppliers, as well as customers and diesel engine designers, have learned over time to manage the cold flow problems associated with winter temperatures. Common practices are:

- Blending with No. 1 diesel
- Utilization of an additive that enhances cold flow properties
- Utilization of fuel tank, fuel filter or fuel line heaters
- Storage of vehicles in a garage.

During the last seven years, the cold flow properties of biodiesel and biodiesel blends have been thoroughly tested. Biodiesel blends (primarily B20) have been used under a variety of conditions—even during some of the coldest winter weather on record—without cold flow problems.

For example, in the forests of Wyoming, park rangers and other workers depend on their vehicles to operate reliably whenever and wherever needed. According to Robin J. Brooks, a district fleet manager for the USDA Forest Service in Wyoming (where about 55 vehicles run on B20 year-round), vehicle dependability becomes even more important during winter when temperatures can hover at 45 degrees below zero for weeks at a time. "We've always used No. 1 diesel instead of No. 2 during cold weather, and now we just blend the biodiesel into the No. 1," Brooks says. "It's gotten down to 46 degrees below zero, and we don't have any problems."

Agricultural Research Service engineer Robert Dunn inspects chilled biodiesel that has been winterized for better start-ups. (Courtesy USDA-ARS)



A study performed by the USDA is representative of the majority of published biodiesel cold flow testing results (see chart). This cloud point data shows that below-freezing temperatures can be tolerated by typical biodiesel blends (B20 or less) without problems. Biodiesel does gel faster than most No. 2 diesel and the higher the concentration of biodiesel, the sooner the fuel will gel. However, below 20% the cold flow properties of the blend are very similar to those of the petroleum diesel base, and blends below 5% are indistinguishable. This was verified recently by testing performed at System Lab Services, a division of Williams Pipeline, using fuel provided by the Agricultural Utilization and Research Institute in Mankato, Minnesota (see table on page 18). This data shows that the cold filter plugging point (CFPP) of 2% and 5% blends with typical Minnesota winter diesel fuel were all within the variability of the test method. As with diesel fuel, the cold flow properties of biodiesel can vary from supplier to supplier, so customers should work with their fuel suppliers to select the biodiesel and the biodiesel/diesel combination that best meets their needs.

Biodiesel and Engines:
The Standard Has Been Set

In the United States, the American Society for Testing and Materials (ASTM) is the organization that sets the fuel standards

continued on page 18

Biodiesel Is Lubricity

by Paul Nazzaro, Advanced Fuel Solutions, Inc.

Environmental regulations have had and will continue to have a significant impact on the formulation of diesel fuel. The introduction of new fuels and engine designs to meet new emission regulations has created the need to address a number of fuel properties, in order to guarantee acceptable emissions performance while avoiding engine maintenance problems.

What Makes A Premium Diesel Fuel?

Diesel equipment operators nationwide contend that in special situations or in certain geographic locations, they can benefit from a fuel supply with properties beyond minimum ASTM D 975 specifications. Accordingly, over the last decade there has been an increase in the number of fuel marketers offering enhanced fuels at enhanced prices, often called "premium" diesel fuels. Along with these fuels have come claims of exaggerated benefits that are rarely verifiable. To date two groups, the National Conference on Weights and Measures (NCWM) and the Engine Manufacturers Association (EMA), have proposed definitions for premium diesel.

The NCWM addressed the premium diesel issue to ensure that the consumer received a functional benefit in return for a "premium" fuel's higher price. To ensure objectivity, the NCWM formed a task force consisting of refiners, additive manufacturers, independent labs, and government agencies, and tasked it with defining the parameters of a premium fuel. The group was guided by two principles: any enhanced property of a premium fuel must provide a functional benefit to consumers, and must be technically verifiable.

While there are a number of critical diesel fuel performance parameters, lubricity is one of major importance. However the task force realized that setting a lubricity requirement to avoid excessive fuel system wear would be difficult because the available test methods have poor precision and fail to accurately predict performance for all fuel and fuel additive products. Currently, meetings spearheaded by the ASTM Lubricity Task Force are shaping up to identify a testing protocol that satisfactorily benchmarks a fuel's lubricity value. Once this testing protocol is validated, lubricity will most likely be another performance parameter added to the NCWM premium diesel standards.

Lubricity Key to Engine Performance

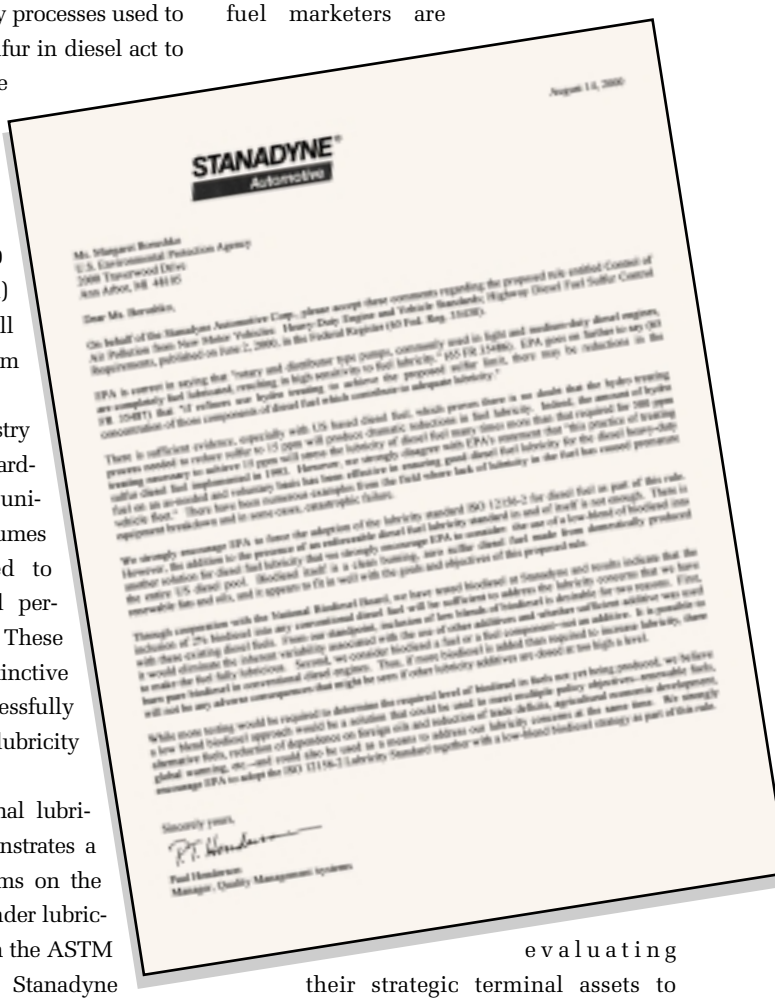
Diesel fuel acts to lubricate moving parts of fuel pumps and injectors, and to avoid excessive wear the fuel must have a minimum degree of lubricity. Refinery processes used to decrease the amount of sulfur in diesel act to reduce its lubricity, and use of a fuel with poor lubricity can increase wear and cause catastrophic engine failure in some cases. This is true with current 500 parts per million (ppm) diesel, and the problem will be exacerbated by the 15ppm fuel anticipated.

As the biodiesel industry has developed, highly regarded independent labs and universities have amassed volumes of technical data related to biodiesel's properties and performance characteristics. These data show that this distinctive alternative fuel can be successfully employed as a diesel fuel lubricity supplement.

Biodiesel has exceptional lubricating qualities and demonstrates a measurement of 6000 grams on the "scuffing load ball-on-cylinder lubricity evaluator" as defined in the ASTM PS-121 quality standard. Stanadyne Automotive Corp., the largest diesel fuel injection equipment manufacturer in the U.S., submitted a letter to the EPA during the comment period of the recently finalized low-sulfur rule which states that Stanadyne supports "the use of a low blend of biodiesel into the entire US diesel pool" for lubricity purposes (see graphic). Stanadyne's tests showed that 1% biodiesel can improve the lubricity of diesel fuel by up to 65%.

Distribution Network Grows As Demand Poised To Expand

The biodiesel distribution network expands daily, as new markets continue to unfold. Numerous national and regional petroleum organizations have embraced biodiesel as a legitimate liquid alternative fuel option. In addition to that high volume marketplace, fuel marketers are evaluating their strategic terminal assets to determine cost effective methods for blending low ratios of biodiesel into conventional diesel fuel. With six multi-functional soy-based diesel fuel supplements commercially available and compelling empirical data supporting its benefits, biodiesel is an obvious choice to remediate the impact of ultra low sulfur diesel on lubricity values. ◆


STANADYNE®
Automotive

August 14, 2000

Ms. Margaret Rosenkis
U.S. Environmental Protection Agency
2000 Traverwood Drive
Ann Arbor, MI 48105

Dear Ms. Rosenkis,

On behalf of the Stanadyne Automotive Corp., please accept these comments regarding the proposed rule entitled Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards; Highway Diesel Fuel Sulfur Control Requirements, published on June 2, 2000, in the Federal Register (65 Fed. Reg. 35430).

EPA is correct in noting that "rotary and distributor type pumps, commonly used in light and medium-duty diesel engines, are completely fuel lubricated, resulting in high sensitivity to fuel lubricity." (65 FR 35486). EPA goes on further to say (65 FR 35487) that "if refiners use hydro treating to achieve the proposed sulfur limit, there may be reductions in the concentration of those components of diesel fuel which contribute to adequate lubricity."

There is sufficient evidence, especially with US based diesel fuel, which proves there is no doubt that the hydro treating process needed to reduce sulfur to 15 ppm will produce dramatic reductions in fuel lubricity. Indeed, the amount of hydro treating necessary to achieve 15 ppm will assure the lubricity of diesel fuel many times more than that required for 500 ppm sulfur diesel fuel implemented in 1993. However, we strongly disagree with EPA's statement that "this practice of treating fuel on an as-needed and voluntary basis has been effective in ensuring good diesel fuel lubricity for the diesel heavy-duty vehicle fleet." There have been numerous catastrophic failures from the field where lack of lubricity in the fuel has caused premature equipment breakdown and in some cases, catastrophic failure.

We strongly encourage EPA to force the adoption of the lubricity standard ISO 12156-2 for diesel fuel as part of this rule. However, the addition to the presence of an enforceable diesel fuel lubricity standard in and of itself is not enough. There is another solution for diesel fuel lubricity that we strongly encourage EPA to consider: the use of a low blend of biodiesel into the entire US diesel pool. Biodiesel itself is a clean burning, zero sulfur diesel fuel made from domestically produced renewable fats and oils, and it appears to fit in well with the goals and objectives of this proposed rule.

Through cooperation with the National Biodiesel Board, we have tested biodiesel at Stanadyne and results indicate that the inclusion of 2% biodiesel into any conventional diesel fuel will be sufficient to address the lubricity concerns that we have with these existing diesel fuels. From our standpoint, inclusion of low blends of biodiesel is desirable for two reasons. First, it would eliminate the inherent variability associated with the use of other additives and whether sufficient additive was used to make the fuel fully lubricious. Second, we consider biodiesel a fuel or a fuel component—not an additive. It is possible to have pure biodiesel in conventional diesel engines. Thus, if more biodiesel is added than required to increase lubricity, there will not be any adverse consequences that might be seen if other lubricity additives are dosed at too high a level.

While more testing would be required to determine the required level of biodiesel in fuels not yet being produced, we believe a low blend biodiesel approach would be a solution that could be used to meet multiple policy objectives...renewable fuels, alternative fuels, reduction of dependence on foreign oils and reduction of trade deficits, agricultural economic development, global warming, etc.—and could also be used as a means to address our lubricity concerns at the same time. We strongly encourage EPA to adopt the ISO 12156-2 Lubricity Standard together with a low-blend biodiesel strategy as part of this rule.

Sincerely yours,

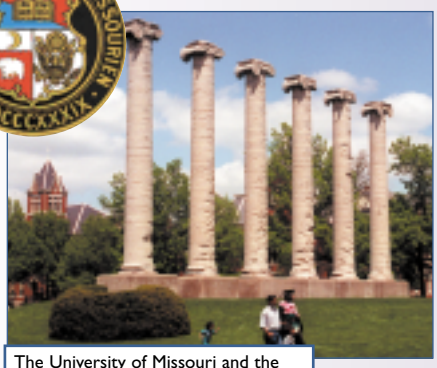
Paul Henderson
Manager, Quality Management Systems

What is Biodiesel?

Biodiesel is the name of a clean burning mono-alkyl ester-based oxygenated fuel made from soybean oil or other vegetable oils or animal fats. A renewable fuel domestically produced from agricultural resources, biodiesel is simple to use, biodegradable, nontoxic, and essentially free of sulfur and aromatic compounds.

The concept of using vegetable oil-based fuel dates back to 1895 when Dr. Rudolf Diesel developed the first compression-ignition engine specifically to run on vegetable oil. Because it has similar properties, biodiesel can be blended in any ratio with petroleum diesel and can be used in diesel engines with no major modifications.

Biodiesel is registered as a fuel and fuel additive with the Environmental Protection Agency (EPA) and meets clean diesel standards established by the California Air Resources Board (CARB). Neat (100%) biodiesel has been designated as an alternative fuel by the Department of Energy (DOE) and the US Department of Transportation (DOT). Biodiesel contains no sulfur or aromatics and already meets the 2007 sulfur standards.



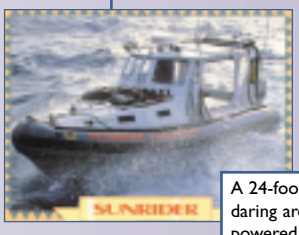
The University of Missouri and the Missouri Soybean Merchandising Council fund a study to demonstrate the use of soy-based mono-alkyl esters as a diesel fuel replacement

Biodiesel pilot demonstrations in dozens of fleets, including Lambert International Airport (St. Louis), New Jersey Highway Department, and U.S. Postal Service

1990 | 1991 | 1992 | 1993 | 1994 | 1995

At the Paris Exhibition in 1900, Dr. Rudolf Diesel demonstrates his new engine using vegetable oil as a fuel

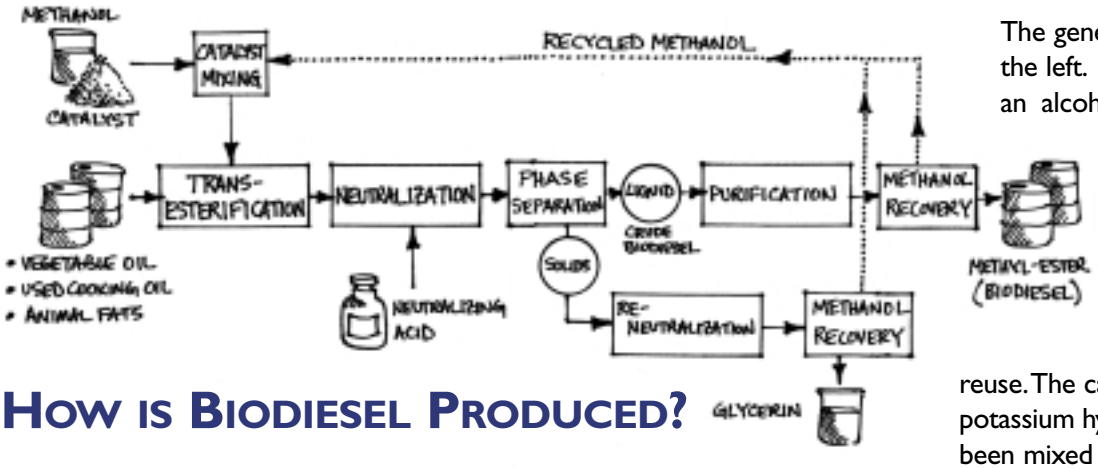
National Biodiesel Board founded to coordinate state and national biodiesel development



A 24-foot Zodiac boat begins a daring around-the-world journey powered by 100% biodiesel

Biodiesel Timeline

The production of biodiesel, or alkyl esters, is a well understood process. Most biodiesel is produced through the process of base catalyzed transesterification, because the reaction is low temperature (150 °F), low pressure (20 psi) and has a high conversion factor (98%) with minimal side reactions and reaction time.



How is Biodiesel Produced?

The general process is depicted on the left. A fat or oil is reacted with an alcohol (like methanol) in the presence of a catalyst to produce glycerine and methyl esters or biodiesel. The methanol is charged in excess to assist in quick conversion and recovered for reuse. The catalyst is usually sodium or potassium hydroxide which has already been mixed with the methanol.

25 fleets using biodiesel for EPAact compliance

Congress approves biodiesel as alternative for compliance with the Energy Policy Act of 1992

Two major biodiesel fuel suppliers registered with EPA

The American Society of Testing and Materials (ASTM) issues specification for biodiesel fuel, approved June 1999

USDA issues final rule for bioenergy program (under the Commodity Credit Corporation), designed to encourage production of environmentally friendly fuels made from soybeans, corn and other crops

Seven companies commercially marketing biodiesel products as premium lubricity additives and 17 biodiesel fuel suppliers registered with EPA

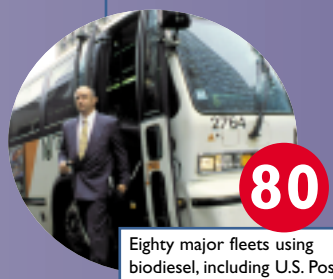
President Bush announces energy plan which further promotes renewable energy, including biodiesel

1996 | 1997 | 1998 | 1999 | 2000 | 2001

President Clinton signs Executive Orders 13101, 13134 and 13149 setting federal government goals for displacing petroleum and tripling use of bio-based products

Three major fleets using biodiesel for EPAct compliance

Biodiesel becomes only alternative fuel to successfully complete the EPA's Tier I and Tier II Health Effects testing



Eighty major fleets using biodiesel, including U.S. Postal Service, universities, transit authorities and school districts

More than 30 million successful U.S, road miles (and countless off-road and marine miles) logged by fleets using biodiesel and biodiesel blends

30,000,000

New Jersey School District Gives Biodiesel an A+

Joe Biluck is an enthusiastic kind of a guy. If he likes something, he lets you know. Talk to him for five minutes and you can tell he loves his job as Director of Operations and Technology for the Medford School District in New Jersey. Talk to him about his 44-vehicle fleet of school buses and his great enthusiasm for biodiesel is sure to surface. With four years of experience using soy-based biodiesel, Biluck knows what he's talking about, but what makes him happiest is the following anecdote.

When Medford School District started using B20 in 1997, one of his drivers was particularly skeptical. "She just couldn't see how her bus could run well on a fuel made from vegetable oil," Biluck remembers. "But you see, the bus she drives transports handicapped students who aren't able to just jump off the bus and head for a pick-up baseball game, but need time and often help to get on and off the bus. In the process, with this particular vehicle, they're exposed to exhaust fumes from the nearby tail pipe," he explains. "The once skeptical driver said her kids noticed the difference right away. They weren't struggling to breathe and weren't bothered by the obnoxious odor of standard diesel fuel," he says. "And oh, by the way, she has had no complaints about how her bus runs on 'vegetable oil' either!"

In fact, Biluck says that operationally there is no difference between the 22 buses he fuels with B20 and the 22 buses he runs on petroleum diesel fuel. "Same mileage and same start-ability. We've had temperatures as low as 11 degrees below zero and had no trouble starting our biodiesel buses."

After 400,000 miles of road testing, Biluck has noticed two significant advantages with biodiesel compared to regular diesel fuel. "I'm not sure why, but the biodiesel buses have less idle vibration." He says he thinks it's due to the increased oxygen content of biodiesel as well as its increased lubricity compared to petroleum diesel fuel. I know for sure we have improved emission quality with biodiesel in total hydrocarbons, carbon dioxide, and carbon monoxide. This is according to U.S. EPA approved tests, conducted by the State of New Jersey, on Medford buses run with both fuels," he states. "We know biodiesel is doing a better job environmentally." ◆

Joe Biluck recommends biodiesel to every school bus fleet manager he meets.

Want to learn more about biodiesel? Visit the National Biodiesel Board web site for biodiesel facts, news and suppliers: http://www.biodiesel.org or call: 1-800-841-5849

Savannah River, South Carolina DOE Facility Switches to Biodiesel

Chris Goodman has only been using biodiesel since January 2001, but he likes what he sees. "If it's diesel and it's used at Savannah River, it's powered by B20," says Goodman, Operations Officer at the U.S. Department of Energy's Savannah River Site (SRS). "We have 190 diesel vehicles and 431 pieces of portable equipment powered by diesel engines, and each and every one is using B20."

Chris Goodman pumping biodiesel at the Savannah River Site.

The Savannah River Site is currently using about 35,000 gallons of B20 (20% biodiesel/80% diesel) a month to earn Alternative Fuel Vehicle credits required by the Energy Policy Act (EPAct). Goodman says the switch from regular diesel to biodiesel couldn't have gone more smoothly. "We haven't had a single complaint or problem," says Chris. "The biodiesel is similar in terms of fuel consumption and horsepower and it integrates easily into our existing fueling tanks."

Like all first time biodiesel users, Goodman is pleased by the fact that there is no costly and time-consuming conversion process required to accomplish the switch. "B20 costs us only about 20 percent more than standard diesel fuel, and we feel the cost is justified. It provides greater lubricity, which we believe will eventually lead to decreased maintenance costs, and it reduces most regulated emissions significantly. It also helps to reduce our dependence on foreign oil and provides a larger market for American soybean farmers," he adds.

DOE plans to expand the use of biodiesel beyond SRS. "The Department of Energy will rely on biodiesel blends to achieve a large portion of the 20 percent reduction in petroleum use called for by 2005 in Executive Order 13149," says Lee Slezak of the DOE Advanced Vehicle Test & Evaluation program. As a DOE facility, Goodman says SRS has two operational imperatives that apply to its use of biodiesel. The first is finding cost-effective ways to accomplish any task, and the second is transferring environmental technology to both government and non-government entities. "As I see it, says Goodman, biodiesel helps us fulfill both of those mission imperatives." For more information on the Savannah River Site, check out http:/www.srs.gov/. ◆

Southern Electric Utilities Get a Real (EPAct) Charge with Biodiesel

Some might find it ironic, others predictable, but two large electric companies are finding biodiesel–B20 to be exact—to be a great way to comply with EPAct rules and earn EPAct credits. As electric utilities, they of course would prefer to use their own "fuel" with electric vehicles (EVs) as EPAct alternatives, and they do, but that can only go so far. Not all EVs work in every situation.

For Florida Power & Light (FPL) and Alabama Power (AP), biodiesel has been the alternative fuel of choice for the last two-and-one-half years. Both Tim Calhoun of FPL, and Richard Harper of AP will recount that their companies started with biodiesel on a trial basis but now use it regularly. What's more, they use it as extensively as they can under EPAct rules. "We hope EPAct will change its rules to allow us to earn even more credits with B20," says Harper. "What we like about biodiesel is that it requires no conversion or purchase of new equipment," explains Calhoun. "You just start using it. When we began with B20, we did it as a test and part of that test was to find out if our operators noticed the difference. They didn't. We had no complaints at all."

For fleet managers considering biodiesel, Calhoun recommends their number one concern be finding the right supplier. "Make sure to find a supplier who can work with you to meet your needs. For example, we store no fuel at our facilities. Each vehicle is fueled by our supplier each evening and they have to be willing to bring the blended B20 from their facility," he says.

Beyond earning EPAct credits, Calhoun says they have found that using biodiesel at FPL has other benefits. "It definitely increases the lubricity of the fuel and our tests show it has reduced emission of hydrocarbons, particulate matter and carbon dioxide. We've also found it really does clean up the fuel system."

At Alabama Power, Richard Harper says they use the alternative fuel in 30 to 40 trucks in the Birmingham area.

Florida Power & Light started with biodiesel on a trial basis and now uses it as much as possible.

"The fuel has to be versatile in that some of the vehicles are older—up to 15 years—and others were new when we started with biodiesel. We have a variety of engines and a variety of uses and biodiesel has worked well in each case."

Beyond the fact that it required no conversion expense, the choice of biodiesel over propane or natural gas also had to do with availability, according to FPL's Calhoun. "Being a southern state, the infrastructure for propane or CNG alternatives just isn't there," he explains. On the economic side, Harper says the price of biodiesel has gone down recently in their area making it an even better deal.

Fleets get an EPAct credit for every 450 gallons of pure biodiesel used in a 20 percent blend level or higher. Since the incremental cost of pure biodiesel ranges from 25 cents to $1.25 per gallon, the cost of an EPAct credit using biodiesel averages about $450. This is significant since according to FPL, EPAct credits trade for about $2,200 each. The incremental cost for B20 is approximately 10 to 25 cents per gallon, similar to the difference between regular and premium gasoline. Harper adds, "We've increased our use of biodiesel and hope that EPAct rules will change to allow us to earn more credits with the fuel. If they do make a change, there is no doubt we will increase our use to the maximum allowable." ◆

Earning EPAct Credits With Biodiesel

Federal, state and public utility fleets required to collect Alternative Fuel Vehicle (AFV) credits under the Energy Policy Act (EPAct) of 1992 can use biodiesel as their least-cost compliance option.

Under the EPAct Amendment of 1998:

- Fleets may choose to operate existing diesel vehicles that weigh more than 8500 pounds on blends of biodiesel in lieu of purchasing new AFVs.
- For each 450 gallons of biodiesel purchased and consumed, a full vehicle credit is awarded.
- The biodiesel component of the fuel blend must constitute at least 20 percent of the volume of the fuel (B20).
- No additional credit is given for the actual vehicles operating on the biodiesel-blend fuel.
- No additional credits will be given for biodiesel used in vehicles that have already been counted by a fleet toward its AFV acquisition requirements.
- Fleets may substitute their biodiesel fuel consumption for up to 50 percent of their total annual AFV purchase requirements.
- Biodiesel fuel use credits cannot be banked or traded.

The Congressional Budget Office (CBO) determined in 1998 that using biodiesel is the least-cost option among the alternative fuel choices available to meet AFV requirements. The CBO predicted that the federal government would save $10 million annually by using biodiesel in its fleet vehicles.

The EPAct amendment does not impose any new requirements on covered fleets. Instead, it provides greater flexibility for fleet operators who already have the responsibility of complying with the requirements of EPAct to further its goal of reducing dependence on imported petroleum. For more information on EPAct, visit http://www.ott.doe.gov/. ◆

Agriculture Department Chooses Biodiesel For Fleet

One mission of the US Department of Agriculture's Agricultural Research Service (ARS) is to develop and test new uses for American farm products. In the case of biodiesel, it has not only tested the fuel but has also adopted it for use in ARS vehicles at the Beltsville, Maryland facility. What's more, ARS continues to find other uses for biodiesel.

John Van de Vaarst, Director of Facilities Management and Operations, says they use B20 in more than 150 diesel engines at the Beltsville facility. "The engines range from farm tractors to large generators to trucks, and includes one bus and even one Humvee. We find biodiesel to be as reliable and dependable as regular diesel fuel," he adds. "We rely on our own power lines within the facility, and the maintenance equipment we use must work when we need it. We needed our B20-fueled 'cherry picker' to repair down lines and fix pole problems during a frigid, icy spell and we had no problems starting it," says Van de Vaarst. ARS mechanics like it too. "It's easier on their eyes than other fuels and they say that it even softens their hands," he laughs.

Van de Vaarst also likes to tell the story of their large diesel driven mowers. "At first, when we hadn't yet told our operators they were burning B20, one of them came in complaining that he was being chased by bees. We immediately thought it might be due to the pleasant aroma from the B20," he recounts. "So we parked the mower by some bee hives, and let it run to see if the bees were attracted to the biodiesel. They weren't. Turns out the bees just liked the operator's new after-shave!"

In addition to using biodiesel in ARS's own facilities, Van de Vaarst is promoting it to Washington D.C. Metro area municipalities for large bus transit fleets. "Because you don't have to convert anything and you quickly improve emissions and get healthier exhausts, it makes sense to me," he says. "I know many communities have long range plans to switch buses to other alternative fuels such as natural gas or propane. But if you have a fleet of 2,000 buses you can't afford to make make the switch over night, so why not run the conventional diesel engines that remain in use on B20 and help the city's residents breath cleaner, healthier air?" he asks.

Van de Vaarst is also very enthusiastic about the results of their first year heating with biodiesel. Using B5, a blend of just 5 percent biodiesel, they have had a "flawless-seamless" winter. The biodiesel is used to heat 11 buildings at their dairy research facility, including everything from barns and milk parlors to labs and offices. "The boilers never knew the difference, they never missed a beat. It mirrored the same experience we had with diesel engines," he says. ◆

Photo courtesy USDA-ARS
Check out www.ars.usda.gov

Online Biodiesel Resources

Alt Fuels Data Center
http://www.afdc.doc

National Renewable Energy Laboratory
http://www.nrel.gov

National Biodiesel Board
http://www.biodiesel.org

United Soybean Board
http://www.unitedsoybean.org

A NOTE FROM THE EXECUTIVE DIRECTOR OF THE NATIONAL BIODIESEL BOARD

This is an exciting time for the biodiesel industry. With ten years of testing behind us, the U.S. biodiesel industry has effectively made the transition from the research and demonstration phase to the commercialization phase. More than 80 major fleets currently use biodiesel in their vehicles, and additional fleet managers are choosing it virtually every week. Based on registrations with the Department of Agriculture Bioenergy Program, fuel suppliers anticipate selling *800%* more biodiesel in 2001 than in 2000.

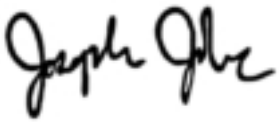
Biodiesel continues to garner interest and support through regulatory activity in more than a dozen states. Some bills encourage the use of biodiesel as a premium lubricity additive while others allow biodiesel to participate in existing state-sponsored alternative fuel programs. The clear benefits of biodiesel have begun to generate broad bipartisan support throughout the country.

Joe Jobe
National Biodiesel Board
Executive Director

Additionally, as the Environmental Protection Agency stands by its decision to lower the sulfur content of diesel from 500 to 15 ppm, biodiesel is well positioned to help replace lost lubricity. Just one to two percent biodiesel restores the lubricity to ultra-low sulfur fuel.

Skyrocketing energy prices have the country reaching for alternatives in a way that has not been seen since the 1970s. Biodiesel is renewable, domestically produced, environmentally friendly and compatible with existing vehicle technology and infrastructure. These factors make it an ideal choice to supplement the country's energy supply. Additionally, it contributes to our national economy and strengthens the farm economy in the form of higher soybean and other agricultural feedstock prices. The success of biodiesel is a prime example of soybean checkoff dollars at work developing new markets for soybeans.

Biodiesel is on the road to fueling the future. To learn more about it, I invite you to visit our Web site at http://www.biodiesel.org.



Joe Jobe

The National Biodiesel Board is a non-profit trade association coordinating the biodiesel industry in the United States.

CONTINUED FROM PAGE 8

RIGOROUS STANDARDS ENSURE BIODIESEL PERFORMANCE

Cold Flow Properties for Biodiesel Blends (Williams)

Blend			CFPP (°F)
No. 1	No. 2	Biodiesel	
50%	50%	0%	-22
49%	49%	2%	-20
47.5	47.5%	5%	-28

for virtually every fuel used in the US. ASTM began the process for setting a biodiesel standard in 1994 and the industry has been hard at work developing all of the data necessary to meet the rigors of ASTM approval.

An ASTM provisional standard for biodiesel, ASTM PS 121 was issued by ASTM in June 1999. The standard covers pure biodiesel (B100) for blending with petroleum diesel at levels up to 20% by volume. Higher concentrations of biodiesel are permitted on a case-by-case basis with approval of the engine manufacturer. It is absolutely critical that biodiesel meet the ASTM standard. (Note: For a copy of the ASTM standard, check www.astm.org). The provisional standard for biodiesel is currently being upgraded by ASTM to full biodiesel standard, and this approval is expected within the year.

Engine Warranties

Diesel engine manufacturers warranty the parts and workmanship of the engines they sell. Typically, a manufacturer will define the recommended fuel for the engine, although they will not cover fuel related problems with any fuel. Most major engine companies have formally stated that the use of a B20 blend or lower will not void their warranties. Some engine companies specify PS 121 quality biodiesel as a condition of the warranty, while others are in the process of adopting PS 121. Like the petroleum industry, most biodiesel companies have liability insurance that would cover any problems due to the use of biodiesel, although there haven't been any problems reported in the field with biodiesel that follows PS 121 standards.

When used in concentrations higher than 20%, biodiesel can soften and degrade certain types of elastomers and natural rubber compounds over time. "There have been millions of on-road miles logged with lower blend levels such as B20 with no adverse affects," according to Roy Truesdale, Director of Operations for the National Biodiesel Board. While the move to 500 ppm sulfur diesel fuel in 1993 caused many original engine manufacturers (OEMs) to switch to components already suitable for use with higher levels of biodiesel, up to B100, fleet managers should contact their OEM for specific information.

Seal of Approval Assures Quality and Performance

The biodiesel industry's commitment to quality didn't stop at setting ASTM standards and working with engine manufacturers. To bolster the confidence that biodiesel marketed in the US meets or exceeds ASTM standards, the National Biodiesel Board (NBB) recently formed the National Biodiesel Accreditation Commission (NBAC). The NBAC audits and certifies biodiesel fuel marketers who have met the quality requirements identified by NBAC. The "Certified Biodiesel Marketer" seal of approval provides additional quality assurance to customers and equipment manufacturers that the biodiesel marketed by these companies maintains the ASTM standards throughout the distribution stream, and that the supplier displaying the seal stands behind its products. ◆

A word from the Petroleum Marketers Association of America

Dan Gilligan, President

As president of the Petroleum Marketers Association of America (PMAA), I would like to congratulate the biodiesel industry on successfully achieving the technical, regulatory and infrastructure milestones that have resulted in biodiesel's commercial success as a fuel and fuel additive.

Virtually the only alternative fuel to integrate seamlessly with diesel technology nationwide, biodiesel shows a great deal of promise and petroleum marketers would be wise to learn more about it. Petroleum marketers are eager to deliver products their customers can benefit from, and biodiesel is one such product. As its use increases, petroleum marketers will continue to integrate biodiesel into their operations, adding both value and market differentiation to their product lines. As a new source of revenue and an aid to national energy security, biodiesel will help ensure the diesel industry continues to grow.

PMAA is a federation of 42 state and regional trade associations representing 7,850 independent petroleum marketers nationwide. Collectively, these marketers sell approximately half the gasoline, 60% of the diesel fuel and 80% of the home heating oil consumed in America. In January 2001, PMAA was pleased to welcome the National Biodiesel Board (NBB) as a national partner. Renewable fuel is an important and timely topic in Washington D.C. and PMAA appreciates the insights the biodiesel industry can offer. Like the fuels themselves, the petroleum and biodiesel industries can blend together perfectly. To learn more about PMAA, visit http://www.pmaa.org.

PMAA PETROLEUM MARKETERS ASSOCIATION OF AMERICA

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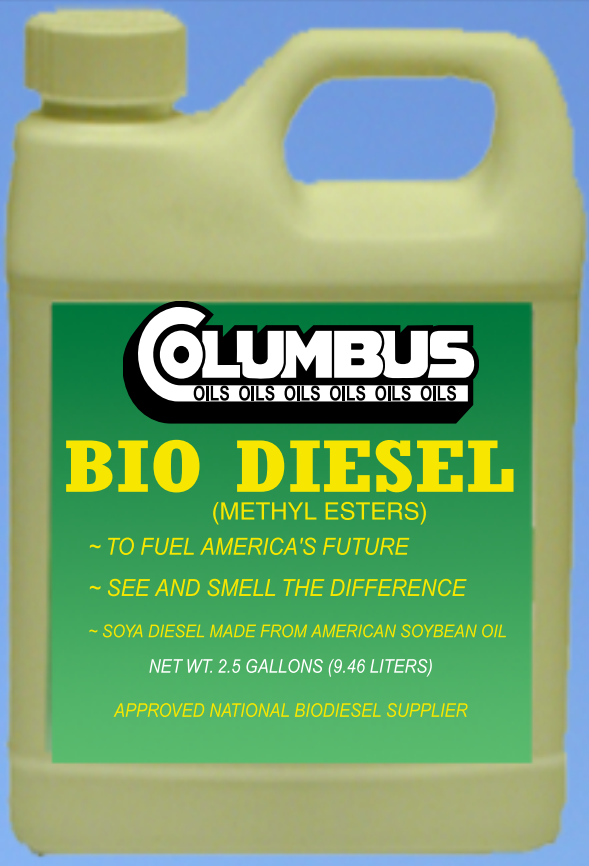

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